DOCUMENT RESUME

ED 392 507 JC 960 172

AUTHOR Wilson, Charles E.
TITLE Comparison of Final Course Grades in Introductory College Chemistry with or without Math Prerequisite.
PUB DATE Dec 94
NOTE 43p.; Ed.D. Practicum, Nova Southeastern University.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Chemistry; College Planning; Community Colleges; *Curriculum Development; *Curriculum Evaluation; *Grade Prediction; Introductory Courses; *Predictor Variables; *Prerequisites; Required Courses; Two Year Colleges
IDENTIFIERS *Donnelly College KS

ABSTRACT

A study was conducted at Donnelly College, in Kansas, to determine whether taking a math course prerequisite affected students' final course grades in an introductory chemistry course. From a sample of 329 students who finished the chemistry course between fall 1985 and fall 1993, course grades were compared for 30 students who had completed the math prerequisite and 30 who had not. Study results indicated that the math prerequisite course was not a significant predictor of higher course grades in the introductory chemistry course. Although the samples used in the study were randomly obtained, the small sample size may have provided unwarranted conclusions. Recommendations from the study include the following: (1) the study should be reviewed by the math and science department administration; (2) the math and science administration should discuss other findings from the literature relative to prerequisite courses, specifically in science education; (3) the study should be replicated; (4) the results should be reviewed by other departments; and (5) a college-wide committee should be established to review the research findings in order to issue a set of recommendations and guidelines on prerequisites and other curricula matters. Contains 57 references. (TGI)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED 392 507

COMPARISON OF FINAL COURSE GRADES IN INTRODUCTORY COLLEGE CHEMISTRY WITH OR WITHOUT MATH PREREQUISITE

Research Methods

Charles E. Wilson
Donnelly College

Marvin Jones
Springfield, Missouri Cluster

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

C. Wilson

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

A Practicum Report presented to Nova Southeastern University
in partial fulfillment of the requirements for the
degree of Doctor of Education

Nova Southeastern University
Revised, December, 1994

JC 960 172

BEST COPY AVAILABLE

Abstract of a Practicum Report Presented to
Nova Southeastern University in Partial
Fulfillment of the Requirements for the
Degree of Doctor of Education

COMPARISON OF FINAL COURSE GRADES IN INTRODUCTORY COLLEGE CHEMISTRY WITH OR WITHOUT MATH PREREQUISITE

by

Charles E. Wilson

December, 1994

This research project was designed to discover whether experiencing a math prerequisite had an affect on student final course grades in the introductory chemistry course at Donnelly College. This introductory course was part of Donnelly's developmental/remedial curriculum. The null hypothesis for two sample groups was that there was no significant difference in final course grades.

Appropriate literature was reviewed. One group each was randomly selected from populations experiencing the math prerequisite and those not experiencing

the math prerequisite before taking introductory chemistry. The course content, objectives, textbooks, laboratories, exams, instructional program, and instructor were the same for both groups. A two-tailed t-test of dependent samples was used to test the null hypothesis.

The literature generally supported the use of a variety of designs and activities to review curricula, instruction, and to enhance learning. Although much of the literature favored the use and usefulness of prerequisite courses, there was support for the idea that prerequisite courses may not be useful in some learning situations. In support of that position, this study found no significant difference in grades of introductory chemistry students who experienced a math prerequisite and those who did not.

As a result of this study, the following recommendation summary was made: This study be reviewed by the chair and faculty of the Math and Science division of Donnelly College, and shared with others, including the academic dean of the college. The Math and Science division chair, along with faculty ought to review other appropriate literature relevant to prerequisites

and developmental curricula. Third, this study should be replicated to allow the Math and Science division staff to collect additional research data on their students and their science program prerequisites.

TABLE OF CONTENTS

Page

Chapter

1. INTRODUCTION 6

Background and Significance 6

Purpose 7

Research Question 9

Research Hypothesis 9

2. REVIEW OF THE LITERATURE 10

3. METHODOLOGY AND PROCEDURES 20

Data Collection 20

Data Analysis 21

Assumptions 23

Limitations 24

4. RESULTS 25

5. DISCUSSION, CONCLUSIONS, IMPLICATIONS,

AND RECOMMENDATIONS 29

Discussion 29

Conclusions 31

Implications 33

Recommendations for the Improvement

of Practice 34

REFERENCES 36

Chapter 1

INTRODUCTION

Background and Significance

The division of Math and Science at Donnelly College has begun to allow students into the introduction to chemistry course (CH 100) without having had the traditional intermediate algebra (MT 103) prerequisite. The Math and Science division staff has obtained some anecdotal data from students about the introductory chemistry course without the math prerequisite. However, the division staff does not have research data available to suggest whether changing the math requirement has affected student success or student final course grades.

During recent decades, there has been an influx of students seeking social mobility through education. This influx of adult learners, culturally diverse students, and underprepared high school graduates, has forced higher education institutions to review their curricula and their teaching strategies (Cross, 1981 and Evangelauf, 1991). At many institutions, the presence of these high-risk students has forced schools and colleges to analyze institutional process and to

develop skills in helping students help themselves (Chapel, 1991; Fleming, 1984; and Naisbitt, 1982). Developmental courses have been part of this strategy.

The introduction to chemistry course was part of the developmental education program in the sciences at Donnelly College. Donnelly administrative staff, as do others (Reed & Huidepahl, 1983), believe that developmental programs increase student progress and success without minimizing educational quality.

Purpose

The purpose of this study was to discover whether experiencing a math prerequisite (intermediate algebra) had an affect on student final course grades in the introductory chemistry course at Donnelly College. This work attempted to provide research evidence that successful passage of introductory chemistry can be obtained with or without the usual intermediate algebra prerequisite. The research hypothesis was that the usual math prerequisite (intermediate algebra) was necessary to produce higher final course grades for introductory chemistry students (H_1: $u_1 > u_2$).

It was thought that if this study could show that students make better or equal grades in the introducto-

ry chemistry course without experiencing the math prerequisite, there would be benefits for both the students and the college. Some of the suggested benefits included the following:

1. More Donnelly College students would be able to enroll in introduction to chemistry earlier than usual

2. Students would be able to start the science curriculum sooner than with the math prerequisite

3. Increased numbers of students enrolled in the five credit hour science courses would increase the total number of FTE's for the college

4. Increased numbers of students who obtain the Associate degree

In the literature, there appeared to be significant interest in the idea of courses designed to remediate, prepare academically underprepared, and how such courses could best be developed. There was also a great deal of focus on how such courses might be applied to help students who enroll in them, to experience success.

The Research Methodology seminar dealt with a number of facets related to research and evaluation. Planning a research project, preparing a research proposal, treatment of the data and preparing the research report were some of the important topics covered. This seminar also suggested research and evaluation as it occurs in a work setting. This proposal attempted to make such a connection by proposing to solve a problem and answer some questions within the context of my employment with Donnelly College in Kansas City, Kansas.

Research Question and Research Hypothesis

As directed by the seminar, this study, through research, sought to understand the relationship between student final course grades in an introductory chemistry course and a math prerequisite usually required. It was anticipated that there would be no significant difference in the course grade between students taking the introductory chemistry courses without experiencing the math prerequisite and those taking the introductory chemistry course after experiencing the math prerequisite.

BEST COPY AVAILABLE

Chapter 2

REVIEW OF LITERATURE

In order to realize their academic missions and respond to state demands for access, assessment, and accountability, the nation's community colleges, along with other institutions of higher education, focused increasingly on the enhancement of academic support services. A considerable number of students reach college with limited skills, minimal traditional preparation, and lacking in the usual prerequisite courses (Bengis, 1990; Snouffer, 1992; and Trawick, 1992). At many institutions, the presence of large numbers of high-risk students has forced schools and colleges to analyze institutional processes and to develop skills in helping students help themselves. Academic enhancement and support at community colleges was discussed (Andersen, 1988; Cahalan, 1990; Cohen, 1991; Dillon, 1991; Prager, 1991; Raisman, 1992; and Tomilinson, 1989) and evaluated. Learning centers represented an important means of providing learning assistance. They existed in various forms under various names on different campuses. Discipline-based support activities, while found more often at senior

institutions, also existed at some two-year colleges (Bengis, 1990; LaPaglia, 1990; and Mizer, 1990). A considerable number of students reach college with limited skills, minimal traditional preparation, and lacking in the usual prerequisite courses (Bengis, 1990; Snouffer, 1992; and Trawick, 1992). At many institutions, the presence of large numbers of high-risk students has forced schools and colleges to analyze institutional processes and to develop skills in helping students help themselves. Remedial and developmental courses have been part of these strategies (Chapel, 1991; Fleming, 1984; and Naisbitt, 1982).

Rethinking and evaluating and redesigning curricula were also part of the efforts to provide the best possible learning experiences for students. Skala (1988) developed an artificial intelligence course for liberal arts students. Stephens (1984) studied the relationship between computer science aptitude and success in statistical methods courses. Huang & Aloi (1991) developed a computer-assisted interactive videodisc to be used in introductory biology. In 1990 (Biermann & Sarinsky) studied the effects of hands-on versus remediation-based biology preparatory courses

for biology. Healy (1989) studied the effects of advance organizer and prerequisite knowledge passages on the learning and retention of science concepts. Ross (1989) and Saunders & Jesunathadas (1988) generated data to demonstrate that student familiarity with the content used in proportional reasoning test items affects student performance. Feisel, Arneson & Schmitz (1981) developed a slide-tape auto-remediation system, while others used a variety of methods.

Ronca (1985) described a strategy to increase the use of science labs by teachers and students. She reported that this science instruction approach used hands-on-experience stations with peers as the lab assistants. Hofmeister, Engelmann & Carnine (1989) described the development of and validation of video discs to be used in science education. The disc were designed to enhance the efforts of teachers working in both individual and small group instructional settings. The data indicated that video disc programs can enhance the effectiveness of teachers and substantially impacted student achievement and attitudes. Hunter (1988) prepared a study of the use of television cassette tapes in freshman chemistry. Although his aim was to

gather data to see if the tapes had any effect on exam grades, one of his major conclusions was that among student deficiencies, poor math preparation and poor high school chemistry preparation were primary.

Ross and Roe (1986) discussed comprehensive programs to enable students to acquire skills necessary for college work. They suggested developmental courses as supplements to regular academic courses. Others (Abraham, 1987; Budig, 1986; Higbee, 1987; Presley, 1981; Reed, 1983; and Tomlinson, 1989), support the emergence of developmental and remedial programs for high-risk students in English, computer, nursing and science. Herron (1984) examined how information from psychological and educational research was used to develop and implement a remedial chemistry course. The focus was on a viewpoint of the learning process based on cognitive science and involved several instructional strategies. The most important strategy was the modification of instruction in response to new research on teaching and learning.

Tomlinson (1989) summarized that the most important factors in the success of developmental programs at the postsecondary level were program design and

personnel. Others, including Scherz (1985) investigated students' attitudes about a desirable preparatory pre-academic program in science studies. One finding was that prospective science students expected learning activities to play an important role. Students expected the learning to influence future success in university studies. In a study investigating test anxiety, math anxiety and teacher feedback among university students enrolled in remedial mathematics classes, Green (1990) indicated that test anxiety had a significant effect on remedial mathematics students' achievement. Stravitz (1989) suggested that teacher knowledge of science processes was positively related to student success. Hoff (1982) from the University of Northern Iowa, described a movement to increase math and science graduation requirements. Hummelberger et al. (1982) described a systematic process for prerequisite course evaluation in a baccalaureate nursing program. They determined that some prerequisites were useful and others were not useful. It appeared that the usefulness of the prerequisites had to do with their consistency with program philosophy and relevance to course concepts.

Among those who viewed prerequisites as useful, the Ad Hoc Committee on Prerequisites and Matriculation in 1992 said that prerequisites were necessary measures of readiness for courses or programs that students are require to meet as a condition of enrolling in a course or program. Griffin (1984) suggested that there was a need to improve academic counseling of students with respect to science and math prerequisites. The 1984 Teacher's Guide to Advanced Placement Courses in Biology, a 1984 article on curricula guidelines for oral biology, and the 1988 Guidelines for Chemistry and Chemical Technology Programs in Two-Year Colleges, all supported the need for and use of math prerequisites for science courses. Dolberry (1992) supported the use of remedial/refresher courses in math and science. A study conducted at Piedmont Virginia Community College suggested that developmental reading and writing students were more likely than nondevelopmental students to fail or withdraw from nondevelopmental courses (Walsh, 1990).

In another study Formicola (1986) reviewed the adequacy of secondary and undergraduate student preparation for dental school science instruction. The

BEST COPY AVAILABLE

study showed the need for remedial instruction and study skill-building opportunities for students. This study also found that schools needed to be more specific about the kinds of preprofessional training required of applicants.

Coleman (1984) compared the performance of students in high technology programs in engineering and computer science. He emphasized the students' mathematical preparation. In a 1984 article in The Physics Teacher, Uri Haber-Schaim, a Boston University physics professor stated strongly that high school physics should be taught before chemistry and biology. Bohnig (1982) investigated a non-credit, remedial mathematics course for introductory chemistry students. The course was taught before the beginning of a regular semester. Whether one took this course, received basic mathematics or whether one needed to do nothing, was indicated by a test prior to the start of the semester. Kreiser (1981) described a chemistry pre-course for students entering a junior college in Rhode Island. This course was designed to introduce many of the basic scientific concepts deemed necessary before entering the first college course. Additionally, Hunter (1988) found no

significant difference in performance between students who attended television sessions and those who attended live sessions of introductory chemistry classes.

For many, prerequisites generally have been seen as reasonable and necessary. However, there were those who didn't view them as absolutely necessary. Sollimo (1988) reported on several factors in a retention study conducted at Burlington County College. Among those factors was only a slight positive correlation between students previous math experience and success in an introductory chemistry course. "Premastery of specific concepts may not be as important for success in college as personal qualities including motivation, good study habits, perseverance, and ability in mathematics, reading and writing skills." (Yager, Snider & Krajcik, 1988, p. 13).

Biermann and Sarinsky (1987) completed a study to determine whether a biology preparatory course helped students to develop the proper skills and background necessary to successfully complete follow-up courses in biology. Results indicated that a mathematics score was the main discriminator between pass/fail groups of the preparatory course. In another study (Biermann and

Sarinsky, 1990) two different methodological techniques of a biology preparatory course were compared. They attempted to determine which curriculum's methodologies were most effective in preparing biology students for follow-up biology courses. They used course grade as the measure. The results showed that hands-on experience by one group resulted in significantly better grades than either the remediation group or the control group. Others (DeJarnette, 1989 and McDermott, 1989) did similar studies and obtained similar results.

In 1984, Wade Freeman compared the quality of preparation and attrition of students in a traditional remedial chemistry course with students in a remedial course using a personalized system of instruction, self-paced format. The results were that although the personalized system of instruction course suffered heavy attrition, personalized system of instruction students did significantly better in later courses.

A study by Healy (1989) on the effects of advance organizer and prerequisite knowledge passages on the learning and retention of science concepts did not show that either facilitated learning or retention better than the other. Tamir (1989) suggested that students

can achieve as much after studying for a few months to offset any advantage other students may have gained through prerequisite courses.

This practicum is directly related to the Research Methods seminar in that principles and tools of research and evaluation were used in the development of this comparative study. This practicum provided an opportunity to emphasize and understand the relationship between theory, research, and practice. This study also allowed the integration of various research activities in an orderly framework so that the researcher could more easily comprehend research in the academic work enviornment. The completion of this project allowed the researcher to use and understand the major interrelated stages of the research process.

Chapter 3

METHODOLOGY AND PROCEDURES

Data Collection

From the records of the Office of the Registrar at Donnelly College, thirty (30) student final course grades were randomly selected from those who had taken the introduction to chemistry (CH 100) after experiencing the math prerequisite (MT103), and thirty (30) were randomly selected from the group that had taken the introduction to chemistry course without having first experienced the math prerequisite. The total number of students who had taken the chemistry course after experiencing the math prerequisite was approximately 252. This subject population covered the period from Fall 1985 to Spring of 1989. The total number of students who took the introduction to chemistry without experiencing the math prerequisite was approximately 77. The period for this subject population was Fall 1989 to Fall 1993.

The course content and course objectives for introduction to chemistry were the same for the eight-year period of the sample. The instructional program included the same instructor, the same course outline,

the same laboratories, similar textbooks and examinations. Final course grades/scores were compared for the two groups of introductory chemistry students. The independent variable was the presence or absence of the math prerequisite, intermediate algebra (MT 103).

Grades for the course were awarded in the introduction to chemistry course on the following basis: A, B, C, D, F, and W. Numerical scores assigned to each grades for the purposes of this study, was as follows: A=4, B=3, C=2, D=1, F=0, and W=0. The data was presented in a table, showing the two groups, grades, scoring, and totals.

Data Analysis

The Donnelly College registrar provided the student grade records to be reviewed. The student grades covered several semesters of introduction to chemistry. Final course grades were selected from a subject population of just more than three hundred (300) students who had taken the introduction to chemistry course between Fall 1985 and Fall 1993. A sample of thirty (30) random selections were acquired from the group who had taken the math prerequisite and thirty (30) random selections from the group that had not. A continuous

interval of every second student grade was selected to total thirty. Both populations were relatively small as college classes go. Therefore, the sample sizes were similarly small.

Final course grades were compared for the two groups. Numerical identifiers were arbitrarily assigned to each letter grade. The null hypothesis was evaluated using a t-test. The means of the two groups were compared.

The null hypothesis for this study was that there was no difference or relationship between the math prerequisite (independent variable) and the final course grade (dependent variable) of students taking introductory chemistry. Symbolically stated, Ho: $u_1=u_2$. The null hypothesis was to be rejected at the .05 level of significance. The research hypothesis was that the usual math prerequisite (intermediate algebra) was necessary to produce higher final course grades for introduction to chemistry students (H1: $u_1>u_2$). The alternative hypotheses was H_a: $u_1=u_2$.

The population for this study was the total number of students who enrolled for introduction to chemistry at Donnelly College between the Fall of 1985 and the

Fall of 1993. The sampling unit included those students who had received a grade of A, B, C, D, F, or W (withdrawal).

The data were treated as continuous for the purpose of measurement. The study design was a between subject with two interdependent groups. The variable to be tested was the math prerequisite, intermediate algebra (MT 103). A two-tailed t-test was used to test the difference between the means of these two dependent sample groups. Frankfort-Nachmias & Nachmias (1992) supports the use of critical t values when the sample sizes are thirty (30) or less. They suggested that using a normal curve to determine the probability of Ho would yield inaccurate conclusions.

Assumptions

One assumption was that there would be no change in the grading scale or the manner in which grades were assigned to Donnelly College introduction to chemistry students during the period of this research. Another important assumptions was that the course content, structure, instructor, testing, and other procedures for introduction to chemistry was unchanged during the period of study, with the exception of the exclusion of

the independent variable for the test group. Additionally, it was assumed that the research populations would be large enough to select reasonable samples, in order to increase the validity and reliability of the study.

Limitations

The primary limitation was that although there was research in this area, much of the literature tended to be older than Nova expects. Another limitation was the size of the sample populations and thus the size of the samples. Since classes at Donnelly College tended to be small, the sample populations had to encompass several semesters. The average class size at Donnelly ranged from 12-20 students per semester, per class.

Although the samples used in this research study were randomly obtained, the small size of the samples make it difficult to generalize the results to larger populations or other settings. Additionally, the results of this study may be limited to Donnelly College students enrolled in the introduction to chemistry course, using the same instructor, course content, testing, structure, and other procedures.

Chapter 4

RESULTS

Literature was reviewed concerning strategies, special programs, and other efforts that community colleges and other higher education institutions employed for academic support and curricula enhancement purposes. Specifically, literature was reviewed that discussed the necessity for and usefulness of prerequisite courses as part of curriculum planning and maintenance.

From the literature, the following sources were reviewed: the increasing numbers of high-risk students or those with limited traditional preparation for college study (Bengis, 1990; Chapel, 1991; Cross, 1981; Evanglauf, 1991; Fleming, 1984; Naisbitt, 1982; Snouffer, 1992; and Trawick, 1992); necessity of educational enhancement and academic support for such students (Andersen, 1988; Cahalan, 1990; Cohen, 1991; Dillon, 1991; Prager, 1991; Raisman, 1992; and Tomilinson, 1989).

Efforts at rethinking, evaluating, and redesigning curricula were examined in Biermann & Sarinsky (1990), Feisel, Arneson & Schmitz (1981), Healy (1989), Hof-

meister (1989), Huang & Aloi (1991), Hunter (1988), Ross & Roe (1986), Saunders & Jesumathadas (1988), Skala (1988), and Stephens (1984). Other sources geared toward discipline-based support activities included Bengis (1990), LaPaglia (1990), and Mizer (1990). courses.

Literature reviewed concerning the development and implementation of remedial and developmental courses included Abraham (1987), Bohnig (1982), Budig (1986), Dolberry (1992), Green (1990), Herron (1984), Higbee (1987), Hoff (1982), Presley (1981), Reed (1983), Scherz (1985), Stravitz (1989), Tomilinson (1989), and Walsh (1990); the usefulness of prerequisite courses (Ad Hoc Committee on Prerequisites and Matriculation, 1992; Biermann & Sarinsky, 1987, 1990, 1991; Coleman, 1984; DeJarnette, 1989; Formicola, 1986; Freeman, 1984; Griffin, 1984; Guidelines for Chemistry and Chemical Technology Programs in Two-Year Colleges, 1988; Haber-Schaim, 1984; Hummelberger, 1982; Kreiser, 1981; McDermott, 1989; Sollimo, 1988; Tamir, 1989; Yager, Snider & Krajcik, 1988; and Yager & Krajcik, 1989).

The null hypothesis, that there was no significant difference between the scores or the two groups, was

tested using a two-tailed t-test. The sample size for each of the two groups was thirty (30).

According to the distribution tables, the critical t for a two-tailed test at the .05 level of significance was 2.05. The sample mean for the group with the math prerequisite was 2.33. The standard deviation was 12.4 and the degree of freedom was 29 (30-1). For the sample without the math prerequisite, the sample mean was 2.53, the standard deviation was 13.4, and the degree of freedom was 29 (30-1). The standard error for the two sample means was 3.4 and the calculated value of t equalled -.059, while the critical t was 2.05. (see Table 1). The critical value for t to reject the null was 2.05. The calculated value of t was -.059. Therefore, the null could not be rejected.

BEST COPY AVAILABLE

Table 1

Summary Data: Null Hypothesis

Item	With Math Prerequisite N_1	Without Math Prerequisite N_2
Sample size	$N_1 = 30$	$N_2 = 30$
Sample mean	$X_1 = 2.33$	$X_2 = 2.53$
Standard deviation	$S_1 = 12.4$	$S_2 = 13.4$
Degree of freedom (N-1)	(30-1) = 29 =58	(30-1) = 29
Level of Significance	.05	
Standard error	3.4	
Critical t	2.05	
Calculated value of t	-.059	

Chapter 5

DISCUSSION, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Discussion

Literature was reviewed concerning strategies, special programs, and other efforts that community colleges and other higher education institutions employed for academic support and curricula enhancement purposes. Specifically, literature was reviewed that discussed the necessity for and usefulness of prerequisite courses as part of curriculum planning and maintenance. The literature revealed that rethinking, evaluating and redesigning curricula tended to be an ongoing effort to provide the best possible learning experiences for students.

The literature review tended to focus on three areas. One was special programs, activities, and strategies to improve the learning process. The second was the use and usefulness of prerequisite courses in college science courses. Third was the development and evaluation of developmental/remedial courses. A variety of designs and activities were noted for the modification of instruction. Computer-assisted interactive

video discs used in biology courses, slide-tape auto-remediation systems, peer lab assistants, television and cassette tapes, and the development of supplemental and prerequisite courses were some of these activities designed to support and enhance the learning experience for college students in science courses. One important note from the literature was that the success of any developmental program at the postsecondary level was the program design and instructor. This is certainly in opposition to most academic thinking about prerequisites and the developmental process.

The results of the sampling for this study and the value of t would seem to suggest that for this particular chemistry course, math as a prerequisite, is at least negligible in determining higher course grades. The fact that the sample sizes were so small may have affected the results, thereby providing unwarranted conclusions. However, from the results, no statistical difference in final grade was found for students who did or did not take the math prerequisite before taking the introduction to chemistry course.

Conclusions

The literature generally supported the use of a variety of designs and activities to review curricula, instruction, and to enhance learning. In addition, the most important factors discovered for the success of any developmental program at the postsecondary level were the program design and the instructor or personnel. Those who supported the use of math prerequisites or remedial/refresher courses in math and science, generally thought that prerequisites were necessary measures of readiness and thus, ought to be required of students. Others suggested that premastery of specific concepts may not be as important for success in college as personal qualities such as motivation, good study habits, perseverance, and ability in math, reading, and writing skills. Although much of the literature favored the use and usefulness of prerequisite courses, there was some support for the idea that prerequisite courses may not be useful in some learning situations. This point was made in the discussion above. The work by Yager et al. (1988, 1989) is an example of studies which don't support the usefulness of prerequisite courses, particularly in the area of science education.

In support of that position, this research found no significant difference in grades of introduction to chemistry students who experienced a math prerequisite and those who did not. Additional research by Biermann & Sarinsky (1990) showed that hands-on experience in a science class (biology) resulted in significantly better grades than either a remediation group or a control group.

Accordingly, students who take introduction to chemistry at Donnelly College may not need the math prerequisite in order to obtain a reasonably high final course grade.

This study revealed that compared with the values in the sampling distribution of t, (see Table 1), the number of degrees of freedom for sample sizes of thirty (30) and thirty (30) was fifty-eight (58), (30 + 30 - 2), at the .05 level of significance with a two-tailed test, the t for which Ho is to be rejected is 2.05. A t larger than 2.05 is unlikely to occur if H_0 is true. H_0 is true. As -.059 is smaller than 2.05, the null hypothesis is accepted. This research found no statistically significant difference in grades of introductory chemistry students who experienced the math prereq-

uisite and those students who did not. The difference in the final course grades of the two sample groups was not statistically significant.

Implications

One important implication from this study is that students who take the introduction to chemistry course at Donnelly College may not make higher final course grades as a result of taking the usual math prerequisite. Another implication is that this conclusion may hold true for other developmental science courses requiring math as a prerequisite. This conclusion might even hold true for prerequisite courses generally.

Other implications could include the following:

1. The need for review of and possible removal of the math prerequisite for introductory chemistry.
2. The need for review of and possible removal of prerequisite courses for all developmental/remedial science courses at Donnelly College.
3. The need for review of and possible removal of prerequisites generally, in the math and science division of the college, or for that

matter, the entire curriculum containing prerequisites.

4. Review and evaluation of the variety of teaching methods/strategies used at the college.

Such a conclusion would suggest a general review of prerequisite courses at the developmental/remedial level, at the very least.

Recommendations

The most logical recommendation to be made is a continued monitoring of student progress and success in the introduction to chemistry at Donnelly College. This would allow the collection of additional data which could be treated in follow-up studies. Additionally, follow-up studies are also recommended.

Specifically, it is recommended that:

1. This study be reviewed by the chair of the Math and Science division at Donnelly College and shared with appropriate others, including the instructional dean of the college.
2. The chair and faculty of the Math and Science division review and discuss other literature relative to prerequisite courses, specifically those in science education.

3. This study be replicated during the next several semesters, in an attempt to support or refute the conclusions of this study, as well as to provide additional research data to support the changes made in the Donnelly College introductory chemistry course prerequisite criterion.
4. The results of this study, follow-up studies, and other research findings, be reviewed by the chairs and faculty of the other academic divisions at the college, in an attempt to give additional direction to their respective curricula. This could be especially significant for those division curriculums designed to use prerequisite courses.
5. Establish a college-wide committee to review the research findings and their implications for Donnelly College, and to issue a set of recommendations and guidelines on prerequisites and other curricula matters.

REFERENCES

Abraham, Ansley A. Jr. (1982). A report on college-level remedial/developmental programs in sreb states. Atlanta Georgia: Southern Regional Education Board.

American Chemical Society. (1988). Guidelines for chemistry and chemical technology programs in two-year colleges. Washington, D.C.

Andersen, Hans O. (1988, December). The Lesson Plan: Revisited. The Hoosier Science Teacher. 14(2)50-55.

Bengis, Larine. (1991). SEEK and college discovery summer programs: prefreshman, english-as-a second language, postfreshman, and science, mathematics and technology institutes. 1990 Evaluation Reports. Office of Student Affairs and Special Programs, City University of New York, N.Y.

Biermann, Carol A. & Sarinsky, gary B. (1987, April). Analysis of selected cognitive abilities and other factors associated with achievement in a biology preparatory course and beyond at an urban community college. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, Washington, D.C.

Biermann, Carol A. & Sarinsky, Gary B. (1990, October). Selected factors associated with achievement of biology preparatory students and their followup to higher level biology courses. Journal of Research in Science Teaching, 26(7) 575-586.

Biermann, Carol A. & Sarinsky, Gary B. (1991, April). The effects of hands-on versus remediation-based biology preparatory course curricula on performance in follow-up biology courses at the community college level. Paper presented at the Annual Meeting of the National Association for Research in Science Technology, New York, N.Y.

Budig, Jeanne E. (1986). An evaluation of a junior college developmental education program, air. Paper presented at the Annual Forum of the Association for Institutional Research, Orlando, Fl.

Cahalan, Margaret. (1990). Science, mathematics, engineering, and technology in two-year and community colleges. Higher Education Surveys Number 9. Westat Inc.: Rockville, Maryland.

Chapel, Edward V. (1991). Evaluation of college science and technology entry program (cstep), fall 1987 through spring 1991. Queensborough Community College Office of Enrollment Management, Bayside, New York.

Cohen, Arthur M. (1991) Enrollment trends in the Humanities in the community colleges. Paper presented at the National Conference of the Community College Humanities Association. San Francisco, Ca. November 15.

Coleman, Daniel R. (1984, May). Student achievement in high technology programs - community college vs. university mathematical preparation. Paper presented at the Annual Forum of the Association for Institutional Research, Fort Worth, Tx.

Cross, P. (1981). Adult Learners. San Francisco: Jossey-Bass, Inc.

DeJarnett, Patricia. (1989, March). Developmental studies physics: the doors it opens. Paper presented at the Annual Conference of the National Association for Developmental Education, Cincinnati, Ohio.

Dolberry, Jacque. (1992). Nursing education in indian country: salish kootenai college offers a growing nursing program for the flathead reservation. Tribal College: Journal of American Indian Higher Education, 3(3) 20-21.

BEST COPY AVAILABLE

Establishing prerequisites: proposed regulations and guidelines. Academic senate for california community colleges, Sacramento, Ca. (1992). Prepared by the Ad Hoc Committee on Prerequisite and Matriculation.

Evanglauf, Jean. (1991, September 18). Study predicts dramatic shifts in enrollments. The Chronicle of Higher Education, 38(4) A40.

Feisel, Lyle D., Arneson, John R., & Schmitz, Ronald, J. (1981, December). A slide-tape auto-remediation system. Engineering Education, 72(3) 227-230.

Fleming, J. (1984). Blacks in College. San Francisco: Jossey-Bass, Inc.

Formicola, Allan J. (1986). Preprofessional preparation for the basic science curriculum. Journal of Dental Education, 50(8) 458-461.

Frankfort-Nachmias, Chava & Nachmias, David. (1992). Research Methods in the Social Sciences, 4th ed. New York: St. Martin's Press.

Freeman, Wade A. (1984, July). Relative long-term benefits of a psi and a traditional-style remedial chemistry course. Journal of Chemical Education, 61(7) 617-619.

Green, LuEthel Tate. (1990). Test anxiety, mathematics anxiety, and teacher comments: relationships to achievement in remedial mathematics classes. Journal of Negro Education. 59(3) 320-335.

Griffin, Richard A. (1989). Revamping secondary school science education, Paper presented at the National Convention of the Council of States on Inservice Education, Florida.

Haber-Schaim, Uri. (1984, May). In my opinion...high school physics should be taught before chemistry and biology. The Physics Teacher. 22(5) 330-332.

Healy, Vivian C. (1989, October). The effects of advance organizer and prerequisite knowledge passages on the learning and retention of science concepts. Journal of Research in Science Teaching. 26(7) 627-664.

Herron, J. Dudley. (1984, October). Using research in chemical education to improve my teaching. Journal of Chemical Education. 61(10) 850-854.

Higbee, Jeanne I. & GoldbergBell, E. (1987). Meeting the needs of high-risk students through application of theory and research. Paper presented at the Joint Annual Meeting of The American College Personnel Association and the National Association of Student Personnel Administrators, Chicago, Il., March 15-18.

Himlelberger, Ann H., Vermillion, J., Beal, J. A., Edmants, M., Glover, L., & Kneut, C. (1982). Curriculum revision: evaluation of prerequisite courses in a baccalaureate nursing program. Nurse Educator. 7(6) 7-12.

Hoff, Darrel. (1982). Astronomy for nonscience students - a status report. Physics Teacher. 20(3) 175.

Hofmeister, Alan M. (1989). Developing and validating science education videodiscs. Journal of Research in Science Teaching. 26(8) 665-667.

Huang, Samuel D. & Aloi Jane. (1991, May). The impact of using interactive video in teaching general biology. American Biology Teacher. 53(5) 281-284.

Hunter, Norma W. (1980, September). The use of cassette tapes in freshman chemistry. Journal of College Science Teaching. 10(1) 39-41.

Kreiser, Ralph R. (1981, August). Basic skills for chemistry: a pre-chemistry course. Journal of Chemistry Education. 58(8) 636-639.

La Paglia Nancy. (1990). A successful block program that integrates remedial students from diverse cultures. Paper presented at the Annual Conference of The Community Colleges Humanities Association Pacific-Western Division, Portland, Oregon, November 1-4.

McDermott, Lillian C. (1989). Helping minority students succeed in science: development of a curriculum in physics and biology. Journal of College Science Teaching. 9(3) 135-140.

Mizer, Robert. (1990, December). Mathematics: promising and exemplary programs and material in elementary and secondary schools. Mathematics Education Information Report.

Naisbitt, J. (1982). Megatrends. New York, New York, Warner Books.

Prager, Carolyn (1991). Learning centers for the 1990's. ERIC Clearinghouse for Junior Colleges, Los Angeles, California.

Presley, John W. (1981). Evaluating developmental english programs in georgia. Paper presented at the Annual Meeting of the National Council of Teachers of English, Boston, November 20-25.

Raisman, Neal A. (1992). The Defacto state of general education in Michigan community colleges. Council of North Central Community and Junior Colleges, Cincinnati, Ohio.

Reed, Suellen B. & Hudepohl, Nancy C. (1983). High-risk nursing students: emergence of remedial/developmental programs. Nurse Educator. 8(4) 21-26.

Ronca, Courtney C. (1985). Science lab: a peer approach. M.S. Practicum, Nova University, 44 pages.

Ross, Elinor P. & Roe, Betty D. (1986). The case for basic skills programs in higher education. Paper presented at a meeting of Phi Delta Kappa, Bloomington, Indiana.

Ross, John A. (1989). A comment on the effects of task content on proportional reasoning test items. Journal of Research in Science Teaching. 26(7) 649-650.

Scherz, Zahava. (1985). Attitudes of university candidates towards learning activities aimed at preparation for science studies. Paper presented at The Annual Meeting of the National Association for Research in Science Teaching, French Lick Springs, IN., April 15-18.

Skala, Helen. (1988, November). An artificial intelligence course for liberal arts students. Collegiate Microcomputer. 6(4) 311-316.

Sollimo, Vincent J. (1988). A retention study at burlington county college in general college chemistry. New Jersey: Burlington County College.

Snouffer, Nancy K. (1992, May). Measuring and facilitating vocabulary acquisition of basic skills reading students. Paper presented at The National Institute for Staff and Organizational Development's Annual International Conference on Teaching Excellence, Austin, Texas, 24-27

Stephens, Larry J. (1984). The relationship between computer science aptitude and success in statistical methods courses utilizing statistical computer packages. Journal of Computers in Mathematics and Science Teaching. 4(1) 36-37

Strawitz, Barbara M. (1989). The effects of testing on science process skill achievement. Journal of Research in Science Teaching. 26(8) 659-664.

Tamir, Pinchas. (1989, October). Overgeneralized conclusions lead to unwarranted implications. Journal of Research in Science Teaching. 26(7) 643-646.

Tomilinson, Louise M. (1989). Postsecondary developmental programs: a traditional agenda with new imperatives. Higher Education Report. The George Washington University, Washington, D.C.

Trawick, LaVergne. (1992). Effects of a cognitive-behavioral intervention on the motivation, volition, and achievement of academically underprepared college students. Paper presented at The Annual Meeting of the American Educational Research Association, San Francisco, April 20-24.

Walsh, Betty S. (1992, January). Piedmont virginia community college's pathways: the process of developing clusters of nondevelopmental courses for developmental students. Research in Education. 12(7) 19-26.

Yager, Robert E. & Krajcik, Joseph S. (1989, October). Success of students in a college physics course with and without experience in a high school course. Journal of Research in Science Teaching. 26(7) 599-608.

Yager, Robert, E., Snider, B., & Krajcik, Joseph S. (1988). Relative success in college chemistry for students who experienced a high school course in chemistry and those who had not. Journal of Research in Science Teaching. 25(5) 385-396.

BEST COPY A